

**AMENDMENTS TO THE SPECIFICATION:**

Please amend the paragraphs beginning at page 2, line 11, as follows:

According to a first embodiment aspect of the invention, a ceramic carrier capable of supporting the catalyst directly on the surface of the ceramic substrate ~~ceramic~~ is provided, which has a multitude of cells arranged substantially in parallel to each other with the inside thereof serving for ~~as~~ the passage of gas flow and the cell wall having ~~an~~ ~~has~~ irregular surface.

When the cell wall has an irregular surface, the surface area increases and effects can be obtained such as an improved conversion performance, ~~performance~~ due to increased quantity of catalyst which can be supported, ~~supported~~ and prevention of deterioration by increasing the space between catalyst particles. The surface irregularity also has an effect such that the gas flow near the catalyst is disturbed and the probability of making contact with the catalyst increases, thus improving the conversion performance.

The cell wall having an irregular surface may specifically be a ~~the~~ cell wall with a corrugated surface or a roughened surface. Pitch of the corrugated surface is typically set to be not larger than the carrier length. Preferably the pitch of the corrugated surface is 20 mm or less, and more preferably 5 mm or less. Amplitude of the corrugation is set to 1/2 of the cell pitch or less, and is preferably in a range from 1/3 to 1/2 of the cell pitch. ~

An effect similar to that of the surface C irregularity can be achieved also by providing the cell wall with a plurality of projections jutting from the surface inward. In this case, the cross sectional area of the projection is typically set to be not larger than a

half the area of cell opening. Preferably, cross sectional area of the projection is in a range from 1/20 to 1/3 of the area of the cell opening.

Q A ceramic carrier according to a second embodiment aspect of the invention is a ceramic carrier capable of supporting the catalyst directly on the surface of the ceramic substrate-ceramic, which has a multitude of cells arranged substantially in parallel to each other with the inside thereof serving as the passage of gas flow, wherein while the passage of gas flow is not straight.

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Please amend the paragraphs beginning at page 3, line 28, as follows:

Alternatively, as in the case of the ceramic carrier according to a third embodiment aspect of the invention, the passage of gas flow may be curved by disposing the multitude of cells along a spiral. Specifically, the spiral is designed to turn 0.1 degrees or more per 1 m along the flow passage. Preferably, the spiral is designed to make one full turn or more per 1 m along the flow passage, and more preferably two to four turns per 1 m along the flow passage.

Q A ceramic carrier of a fourth embodiment aspect of the invention is a ceramic carrier capable of supporting the catalyst directly on the surface of the ceramic substrate-ceramic, which has a multitude of cells arranged substantially in parallel to each other with the inside thereof serving as the passage of gas flow and the cells have a polygonal, L-shaped, convex, cross, S-shaped or dumbbell configuration or a shape which combines some of the former configurations.

Given the same cross sectional area, the surface area of the cell wall increases

as the cell shape departs from a circle. Thus the surface area can be increased by forming the cell having a cross ~~sectional~~section of shape other than a circle or by combining various shapes. A complicated shape of the cell cross section also causes more disturbance in the gas flow, thereby improving the conversion performance.

02 A ceramic carrier of a fifth embodiment aspect of the invention is a ceramic carrier capable of supporting the catalyst directly on the surface of the ceramic substrate ~~ceramic~~, which has a multitude of cells arranged substantially in parallel to each other with the inside thereof serving as the passage of gas flow, wherein the multitude of cells have a multitude of through holes in the cell wall.

Please amend the paragraph beginning at page 4 line 33, as follows:

03 A ceramic carrier of a sixth embodiment aspect of the invention is a ceramic carrier capable of supporting the catalyst directly on the surface of the ceramic substrate ~~ceramic~~, wherein the substrate ceramic has a porosity of 5% or higher.

Please amend the paragraph beginning at page 5, line 14, as follows:

04 A ceramic carrier of a seventh embodiment aspect of the invention is a ceramic carrier capable of supporting the catalyst directly on the surface of the ceramic substrate ~~ceramic~~, which has a multitude of cells arranged substantially in parallel to each other with the inside thereof serving as the passage of gas flow, wherein density of the cells is 50/in<sup>2</sup> or higher.

Please amend the paragraph beginning at page 5, line 35, as follows:

AS A ceramic carrier of an eighth embodiment aspect of the invention has a multitude of cells arranged substantially in parallel to each other with the inside thereof serving as ~~at the passage for gas flow~~ passage, wherein a plurality of ceramic carriers which are capable of supporting the catalyst directly on the surface of the ceramic substrate ~~ceramic~~ are disposed in series in the direction of the gas flow, so that the cell walls of the plurality of ceramic carriers are discontinuous at ~~their~~ the joints.

Please amend the paragraph beginning at page 6, line 11, as follows:

AS According to a ninth embodiment aspect of the invention, such a carrier can be used as one or more of the elements which constitute the ceramic substrate is substituted with an element other than the constituent element, and the carrier is made capable of supporting the catalyst component directly on the substituting element.

Please amend the paragraph beginning at page 6, line 29, as follows:

AS As the ceramic carrier described above, a carrier may be used that has a multitude of pores capable of directly supporting the catalyst on the surface of the ceramic substrate ~~ceramic~~ so that the catalyst component can be supported directly in the pores.

Please amend the paragraph beginning at page 7, line 12, as follows:

AS For the substrate ceramic described above, a ceramic which includes cordierite as the main component is used, and the pores may be defects formed by substituting a

Q8 part of the constituent elements of the cordierite with a metal element having a different valence value of valence. Cordierite has high resistance against thermal shock and is therefore suitable for the catalyst body to convert the automobile exhaust gas.

Please amend the paragraph beginning at page 7, line 26, as follows:

Q9 A tenth embodiment aspect of the present invention provides a ceramic catalyst body which directly supports a catalyst without forming a coating layer on the ceramic carrier, so as to effectively demonstrate the catalyst performance and high conversion performance.

Please amend the paragraph beginning at page 7, line 36, as follows:

Q10 Fig. 3 shows an example of a cell wall shape having surface irregularity, schematically showing the cell wall having a corrugated surface.

Please amend the paragraphs beginning at page 8, line 20, as follows:

Q11 Now the invention will be described in detail below. According to the invention, a ceramic carrier capable of directly supporting the catalyst component on the surface of the ceramic substrate-~~ceramic~~ is used, and the ceramic catalyst body is made by having a catalyst supported on the ceramic carrier. The ceramic carrier is based on the ceramic substrate-~~ceramic~~ made preferably from cordierite which has theoretical composition of  $2\text{MgO} \cdot 2\text{Al}_2\text{O}_3 \cdot 5\text{SiO}_2$  as the main component. Instead of cordierite, other ceramic materials such as alumina, mullite, spinel, aluminum titanate, titania, silicon carbide and zirconium phosphate may also be used. The ceramic carrier has a configuration such as a honeycomb structure which has a multitude of substantially parallel cells or porous

foamed configuration, which makes it possible to make maximum use of the characteristics of the ceramic substrate-~~ceramic~~ that can directly support the catalyst while increasing the surface area.

Q1 The ceramic carrier has a multitude of pores or elements capable of directly supporting the catalyst component on the surface of the ceramic substrate-~~ceramic~~, so that the catalyst component can be supported directly in the pores or on the elements.

An element which is capable of directly supporting the catalyst component is an element introduced by substituting one or more elements among the constituent elements of the ceramic substrate-~~ceramic~~ with an element other than the constituent element, which will be described in detail later.

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Please amend the paragraphs beginning at page 10, line 13, as follows:

Q2 Oxygen defects may be formed in the crystal lattice as described in Japanese Patent Application No. 2000-104994, in a process after forming and degreasing, by sintering a material for cordierite containing an Si source, an Al source and an Mg source while either ① decreasing the pressure of the sintering atmosphere or making it a reducing atmosphere; ② sintering in a low-oxygen concentration atmosphere using a compound which does not include oxygen for at least a part of the raw material so as create oxygen deficiency in the sintering atmosphere or in the starting material; or ③ substituting at least one of the constituent elements of the ceramic except for oxygen with an element having a valence value-~~of valence~~ lower than that of the substituted element. In the case of cordierite, since the constituent elements have positive valence such as Si (4+), Al (3+) and Mg (2+), substituting these elements with an element of

lower valence value ~~of valence~~ leads to deficiency of positive charge which corresponds to the difference from the substituting element in the value of valence and to the amount of substitution. Thus O (2-) having negative charge is released so as to maintain the electrical neutrality of the crystal lattice, thereby forming the oxygen deficiency.

Q12  
Lattice defects can be formed by ④ substituting a part of the constituent elements of the ceramic except for oxygen with an element which has a valence value ~~of valence~~ higher than that of the substituted element. When at least part of Si, Al and Mg which are constituent elements of the cordierite is substituted with an element having a valence value ~~of valence~~ higher than that of the substituted element, a positive charge which corresponds to the difference from the substituting element in the valence value ~~of valence~~ and to the amount of substitution becomes redundant, so that the required amount of O (2-) having negative charge is taken into the lattice in order to maintain the electrical neutrality of the crystal lattice. The oxygen atoms which have been taken into the crystal make an obstacle for the cordierite unit crystal lattice to form an orderly structure, thus resulting in the lattice strain. Or, alternatively, part of Si, Al and Mg is released to maintain the electrical neutrality of the crystal lattice, thereby forming vacancies. In this case, sintering is carried out in an air atmosphere so as to supply a sufficient amount of oxygen. Since the sizes of these defects are believed to be on the order of several angstroms or smaller, they are not accounted for in the specific surface area measured by ordinary methods such as the BET method which uses nitrogen molecules.

The number ~~Number~~ of oxygen defects and lattice defects is related to the amount of oxygen included in the cordierite honeycomb structure, and it is possible to

support the required quantity of catalyst component by controlling the amount of oxygen below 47% by weight (oxygen defect) or over 48% by weight (lattice defect). When the amount of oxygen is decreased to below 47% by weight due to the formation of oxygen defects, the number of oxygen atoms included in the cordierite unit crystal lattice becomes less than 17.2, and the lattice constant for  $b_0$  axis of the cordierite crystal becomes smaller than 16.99. When the amount of oxygen is increased above 48% by weight due to the formation of the lattice defects, the number of oxygen atoms included in the cordierite unit crystal lattice becomes larger than 17.6, and the lattice constant for  $b_0$  axis of the cordierite crystal becomes larger or smaller than 16.99.

Q12 A predetermined ~~Predetermined~~ number of ~~of~~ or more ~~pores, peres~~ can be formed in the ceramic ~~carriere~~ carrier, when the density of cordierite crystal containing at least one defect of at least one kind, oxygen defect or lattice ~~defect~~ defect, in a unit crystal lattice of ~~cordierite, eordierite~~ cordierite is set to  $4 \times 10^{-6}$  % or higher, and preferably  $4 \times 10^{-5}$  % or higher. ~~Alternatively, higher, or alternatively,~~  $4 \times 10^{-6}$  or more, preferably  $4 \times 10^{-7}$  or ~~more, more~~ defects of at least one kind, oxygen defect or lattice defect, are included in a unit crystal lattice of the cordierite honeycomb structure.

Please amend the paragraph beginning at page 14, line 13, as follows:

Q13 A carrier having a multitude of particles of elements which are capable of supporting the catalyst component directly on the surface of the ceramic substrate ~~ceramic~~ being provided by the substitution of elements will be described below. In this case, constituent elements of the ceramic (for example Si, Al and Mg in the case of cordierite) are substituted with such an element that has greater force for bonding with



the catalyst than the constituent element to be substituted and is capable of supporting the catalyst component by chemical bonding. Specifically, the substituting elements may be those which are different from the constituent elements and have d or f orbits in the electron orbits thereof, and preferably have an empty orbit in the d or f orbits or have two or more oxidation states. An element which has empty orbit in the d or f orbit has energy level near that of the catalyst being supported, which means higher tendency to exchange electrons and bond with the catalyst component. An element which has two or more oxidation states also has higher tendency to exchange electrons and provides the same effect.

Please amend the paragraph beginning at page 15, line 22, as follows:

The amount of substituting element is set within a range from 0.01% to 50%, and preferably in a range from 5 to 20% of the substituted constituent element in terms of the number of atoms. In case the substituting element has a valence value of valence different from that of the constituent element of the substrate ceramic, lattice defects or oxygen defects are generated at the same time depending on the difference in the valence, as described above. But the defects can be prevented from occurring by using a plurality of substituting elements and setting the sum of oxidation numbers of the substituting elements equal to the sum of oxidation numbers of the substituted constituent elements. Thus the catalyst component may be supported only by bonding with the substituting elements while keeping the valence constant as a whole.

Please amend the paragraph beginning at page 17, line 31, as follows:

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Fig. 1 shows the result of measuring the conversion performance of the ceramic catalysts body made by depositing the catalyst component under the same conditions on ceramic carriers having different porosity ranging from about 5 to 50%. The ceramic carriers were made from cordierite materials comprising talc, kaolin, alumina, etc. of which 10% by weight of the Al source is substituted with tungsten oxide having a different valence value ~~of valence~~, the material being mixed with a binder and formed into honeycomb structure which was then dried (90°C, 6 hours) before being sintered at 1300°C or higher temperature for two to five hours thereby forming the defects that would make the pores. Pt and Rh were deposited as the catalyst on the carriers so as to support the predetermined quantity of catalyst (1.5 g/L). An ethanol solution of chloroplatinate and rhodium chloride was used as the catalyst solution. the ceramic carriers were immersed in the solution and were subjected to heat treatment at a temperature of 800°C for two hours in air atmosphere, thereby completing the catalyst.

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